# Progress Report

# Dynamic Response Indicators of Heat Stress in Shaded and Non-Shaded Feedlot Cattle

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## INTRODUCTION

Heat has negative impact on animal performance and well-being. Reductions in feed intake, growth, and efficiency are commonly reported in heat-stressed cattle. The impacts of heat on production are quite varied, ranging from little to no effect in a brief exposure, to death of vulnerable animals during an extreme heat event. An extreme event in July, 1995, caused the loss of approximately 3750 head of cattle in western Iowa; direct losses were estimated at US $2·8 million, and production losses at US $28 million. Feedlot cattle are particularly vulnerable to heat stress as a result of the high-energy diet they are fed, and their inability to move into a more suitable environment.

Results from performance trials with shaded and non-shaded feedlot cattle have shown inconsistent results. A summary of results from several shade studies concluded that feedlot cattle in areas with more than 750h/yr of temperatures above 29·5°C (85°F) generally show a performance improvement, while gains of cattle in areas that receive 500–750h/yr of temperatures above 29·5°C (85°F) are less conclusive. The lack of performance improvement with access to shade from these areas with a milder climate can be explained by the ability of cattle to acclimate and compensate for short-term decreases in feed intake and growth resulting from a heat stress event.

While shades have not consistently shown a performance improvement, cattle with access to shade have consistently shown a reduction in body temperature and respiration rate. During times of high solar radiation, high temperature, and high humidity, a reduction of solar radiation will reduce heat stress, and may improve animal well-being, and prevent death in extreme cases.

The objectives of this study were to evaluate the responses of feedlot cattle (respiration rate, daily feed intake, feeding behavior, and body temperature) to different environmental conditions with and without access to shade, and to determine which measurement was the most appropriate to monitor feedlot cattle under heat stress conditions.

## MATERIALS AND METHODS

Eight crossbred steers (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer, 1/4 Red Poll) initially weighing 294·7±10·8 kg were assigned to one of eight individual concrete-surfaced pens. Four pens allowed access to shade, and the other four pens had no-shade access. These shade structures provided shade from mid-morning to early evening and covered approximately 50% of the pen area. Data were collected during eight periods the summer of 2001.

Respiration rate, body temperature, and feeder weights were recorded every 15 minutes during the experiment. Animal position was recorded every 15 minutes throughout the daylight hours.

Weather information was used to calculate a temperature humidity index (*THI*) – a value which combines the effects of temperature and humidity.

$$THI = temperature + 0{\cdot}36\_dew\text{-}point\ temperature + 41{\cdot}2 \quad (1)$$

The data was then categorized into four groups (Normal, Alert, Danger, and Emergency) using daily maximum temperature humidity index. The Normal category was defined as maximum daily *THI* below 74. The Alert category had a maximum daily *THI* greater than or equal to 74, and less than 78. The Danger category had a maximum daily *THI* greater than or equal to 78, and less than 84. The Emergency category had a maximum daily *THI* equal to or above 84.

## RESULTS

A total of 37 days of data were taken during the summer of 2001. Of those, four were categorized in Normal, six in Alert, 13 in Danger, and 14 in Emergency range.

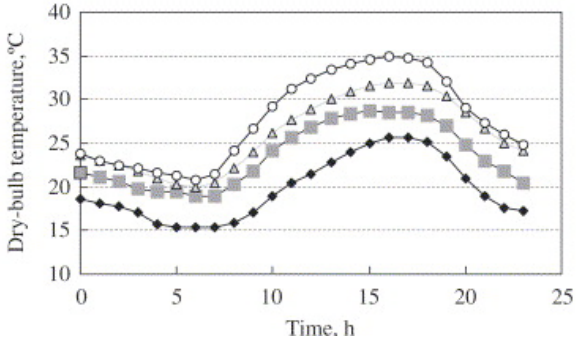


Fig. 1. Average hourly temperature for each of the four heat stress categories based on maximum daily temperature humidity index: (◆) Normal; (■) Alert; (△) Danger; (○) Emergency

### Shade use

There was no difference in percentage of time cattle spent under shade in the lowest three categories (Normal, 80·8±5·6%; Alert, 83·5±5·2%; Danger 83·6±3·3%). However, cattle exposed to the Emergency category spent significantly more time in the shade than in any other category (Emergency, 96·4±3·3%).

### Respiration rate

Overall, it appears that shade access reduced respiration rate during portions of the day in all weather categories. Regardless of weather category, the shaded cattle's respiration rate followed non-shaded cattle's respiration rate until approximately 11:00 h, at which time shaded cattle's response flattened out, while non-shaded cattle's respiration rate continued to rise. The largest impact of shade on respiration rate was during

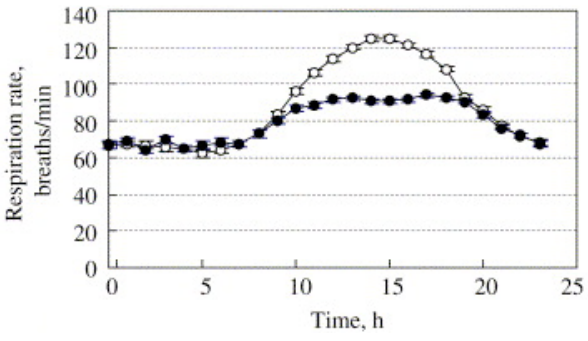


Figure 2. Average hourly respiration rate seen

during the emergency category.

for shaded (–●–) and non-shaded (-○-) feedlot cattle exposed to emergency conditions.

## Body temperature

In all weather categories, shade reduced cattle's body temperature during daytime hours. However, unlike respiration rate, the benefit of shade on body temperature does not have a consistent daily pattern in all weather categories.

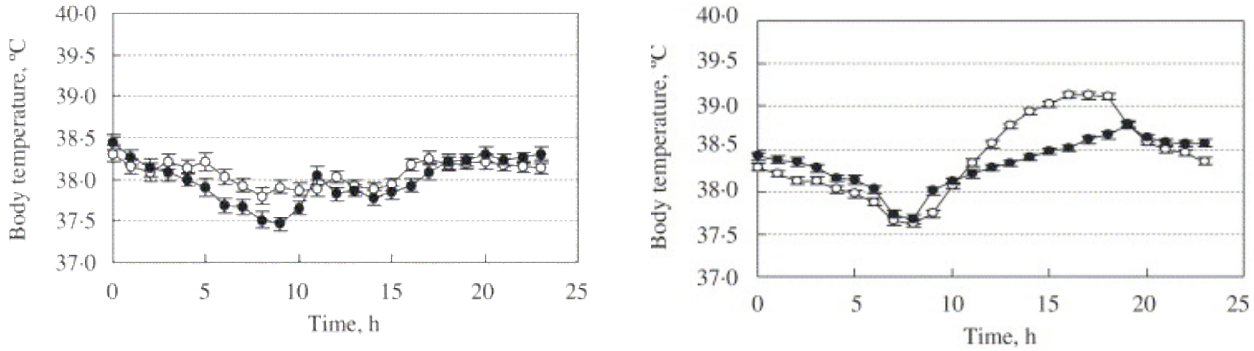


Figure. 3.Average hourly core body temperature for shaded (–●–) and non-shaded (-○-) feedlot cattle exposed to weather conditions in the Normal category (left) and Emergency Category (right).

## Feeding behavior and feed intake

There were no differences in accumulative feed intake in the Normal, Alert or Danger categories. However, in the Emergency category shaded cattle ate more feed from1400h through the remainder of the day.

## SUMMARY

Shade was found to impact physiological responses in all weather categories, with the largest response observed in Danger and Emergency categories. As expected, the largest impact of shade was at higher temperature categories. It appeared that physiological parameters (respiration rate and body temperature) were impacted at lower temperature categories than production-related parameters (daily feed intake, feeding behavior) or behavior changes (shade usage). Respiration rate showed the most consistent diurnal response pattern between animals with and without access to shade. Beneficial effects of shade on body temperature were largest in the Danger and Emergency categories. While shade did not influence accumulative feed intake in the Danger category, it had a 1·2 kg advantage in the Emergency category, which should be favorable for maintaining growth in such conditions.

When managing animals during hot weather, it is critical to have an early indicator of stress. Based on these data, respiration rate is the best physiological indicator of stress in a production setting for several reasons: (1) little or no lag is associated with it, (2) it is consistently affected in all weather categories (shade lowers respiration rate at the same time of day in all categories), (3) it is easy to monitor without costly equipment (manually counting of flank movements using only a stopwatch).